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(19)



(54) NEW MINERAL WOOL PRODUCTS

(71) We, A/S ROCKWOOL, a Danish Company of 2640 Hedehusene, Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns a new modification of mineral wool products belonging to the general class in which the fibres are mutually interconnected at intersection points by means of a bonding agent so as to form a coherent, porous, and elastic product. The bonding agent in such products consists normally of a thermo-hardening or thermoplastic resin such as a condensation product of an aldehyde and a phenolic compound. Other bonding agents may, however, be used.

The known mineral wool products of this kind have mostly been used in the form of mats, plates or formed bodies for providing insulation against heat, cold, fire, and sound. Further uses of bonded mats of glass-wool have been for reinforcing plastics and for the production of roof-covering materials. In such applications of mineral wool products it is usually important that the products are water-repelling although in some cases the behaviour of the product towards water is without importance. Generally, however, such mineral products have been more or less water-repelling so that by immersing such products into water they do not readily take up water. This applies particularly to products bonded with phenolic resins. For certain insulation purposes, moreover, bonding agents having pronounced water-repelling qualities have been developed, i.e. by choosing particular catalysts or by adding oils.

This invention relates to porous mineral wool products for agricultural and horticultural purposes and to methods of producing such products. These products must have

the common property of being readily wettable with water and are thereby clearly distinguishing from mineral wool products for thermal and acoustical insulation, which have to be water-repellent and unable to imbibe water unless the water is applied at a certain pressure. In contrast thereto the products according to the invention are intended to have a certain wettability, so that the exact amount of water, which may be specified by the user is promptly imbibed and distributed by capillary forces over every part of their volume.

The use of mineral wool products for a variety of particular agricultural and horticultural purposes is well known. As described in U.S. Patent No. 2,192,939, an integrated blanket of mineral fibres may be used as a covering on bare soil or embedded in its topmost layer, to secure the successful establishment of a desired vegetation. These mineral fibres are intended to disintegrate and undergo chemical decomposition at a moderate rate under weathering influences, and the chemical composition of the fibres is specified accordingly. Permanent, resilient, precut mineral wool mats for covering of the ground around separate shrubs and plants are known from U.S. Patent No. 2,949,698. Fibres with appreciable chemical resistance are specified. These mats should be promptly wettable, because water should pass through them, and be characterized by low capillarity, because one of the purposes is to protect the ground against evaporation of soil humidity. The application of mineral wool or growth medium for soilless plant growth has repeatedly been suggested. Obviously a chemically resistant fibre substance and wettable products thereof having high capillarity should be selected, because a pronounced ability to retain water evenly and finely distributed together with air over a considerable height is essential for a growth medium.

The water may contain soluble plant nutrients, and air is then necessary for the proper growth and functioning of the plants' roots.

Chemical resistance may for these purposes be tested by immersion of the mineral wool for extended periods of time in water which is kept saturated with carbon dioxide. When no or only trace amounts of alkali and alkaline earth carbonates are found in the water after prolonged immersion, the required chemical resistance may be taken for granted. Wettability is the phenomenon which consists in the adhesion of an extremely thin layer of water molecules to the fibre surface. By capillarity is meant the additional ability of the porous product to take up and retain water in its porous structure, as much thicker water layers may be held between adjoining fibres. Fibre diameter and overall product density are known to determine capillarity of wettable mineral wool products. A minor content of fibres with diameters in the 1μ range is known to impart high capillarity to mineral wool products. The major content may be fibres with diameters in the $5-10\mu$ range to secure structural stability of low density products. Overall densities of up to 200 kg/m^3 may be considered for products in accordance with the present invention.

In order to elicit agricultural and horticultural applications of mineral wool, where wettability and permanence are generally required properties, the following examples are given. High or low capillarity may be specified separately for the different applications:

Wettable mineral wool may be used as cultivation medium for germination of seedlings and propagation of cuttings.
as growth medium for soilless growth of plants in containers as well as in freely planted cultures,
as sucking beds, i.e. supports for containers in order to distribute water and water soluble plant nutrients to plants growing therein,
in granulated form as soil conditioner, i.e. as an addition to horticultural soil, whereby the soil is loosened and improved for plant growing purposes,
as filtering medium, e.g. for surrounding perforated draining pipes buried in the ground.

The preservation of the external shape of preformed mineral wool products for such purposes is essential.

To preserve structure and external shape of mineral wool products under storage, transport, and handling, the fibres are coated with a bonding agent, e.g. phenol formaldehyde resin or urea formaldehyde resin, and mutually connected at intersection points by this bonding agent. Phenol formaldehyde resin is known to provide the most moisture resistant fibre connections, as they certainly must do for these purposes. These resins or combinations thereof may be introduced into

the products by atomization of a solution of the uncured resin in the air wherein the dry fibres, made by a fibre producing device, are primarily dispersed. The coated fibres are assembled on a wire cloth and the bonding resin is cured by heat treatment of the assembled fibres.

Phenol formaldehyde resins, and to a lesser degree urea formaldehyde resins are, however, found to impart water repellency to mineral wool products. Inorganic bonding agents, such as colloidal silica, are known to provide promptly wettable products, but such bonding agents will have to be applied in solution to a thoroughly wetted, preformed blanket of unbound fibres. The wetting compacts the blanket so that inorganic bonding agents are only suited for products with overall densities of 200 kg/m^3 or higher. In a succeeding stage the products have to be dried to secure bonding, but drying of such products is a very slow and expensive undertaking.

For these reasons the said organic bonding agents and others having similar properties are still generally employed in mineral wool products, so that these products are usually water repellent to a certain degree which prevents direct use thereof for the purposes now in view.

Wetting agents may be included in the water used for initial wetting of water repellent products, or sprayed on their external surface before wetting. This method is applicable only for blankets or mats up to 1 cm thickness. When thicker water repellent products have been treated in these ways, the water has been found to pass rapidly along separate channels straight through the underlying layers and to leave other parts of the products unwetted. Water repellent mineral wool products will sink rapidly in water if a wetting agent has been added to the water beforehand, and the pores are thereby completely filled up with the water. When lifted out of the water, the mineral wool after prolonged draining will still retain in its structure much more water than the amount required for its use, e.g. as growth medium.

Mineral wool products in accordance with the present invention are dry porous products having fibres of the mineral wool bonded together by a resin at fibre intersections and throughout the products there is such an amount of such a wetting agent on surfaces of the mineral wool fibres that the products are water-wettable. It has been found that the desired water-wettability can be obtained by use of up to 2% by weight of wetting agent based on the mineral wool fibres and cultivation experiments have shown that such amounts of wetting agents can be used without any deleterious effects on plant growth.

The wetting agent can be incorporated during manufacture of the products. Thus, according to the invention, a method for making the products comprises forming a suspension of mineral wool fibres in air, atomising a wetting agent and a solution of a thermosetting resin into the suspension, collecting the fibres as a fleece and curing the resin by heating. The wetting agent and resin solution may be atomised separately or a single composition comprising both may be atomised.

The invention is illustrated by the following Example.

In a cupola furnace a mineral melt was produced, the melt was delivered to a fiberizing device and fiberized by the action of a series of rotating discs, from which fibres in an amount of 2000 kg per hour were carried by a current of air to an air pervious conveyor, to produce a mineral wool blanket. In airborne condition the fibres were coated with phenol formaldehyde bonding resin in an amount of 12 kg per hour by atomization of an aqueous solution of the bonding resin. 500 litres of an aqueous solution containing 2% by weight of the wetting agent 'Triton' CF10 from Rohm and Haas, Philadelphia, were atomised separately into the air carrying the fibres ('Triton' is a Trade Mark). The blanket was compressed to a thickness of 5 cm and an overall density of 80 kg/m³ and carried through a curing oven at a temperature of 200°C. to set the bonding resin. The mineral wool batts thus produced had normal properties, showing that the inclusion of wetting agent did not influence the properties of the bonding resin. It was found that the batts thus produced, when placed on water imbibed the water in such amounts and so rapidly, that they sank in the course of a few seconds. The normal batts, produced in the same manner without the inclusion of wetting agent, when placed on water will float on the water for several hours.

Cultivation experiments have shown that the inclusion of the wetting agent 'Triton' CF10 in amounts of up to 2% by weight of the mineral wool has no deleterious influence on plants grown in the mineral wool.

Many resin binders suitable for use in mineral wool products must be subjected to a heat curing step after they have been applied to the mineral wool fibres. As it is often preferred that the resin and wetting agent used in making products according to the invention should be applied simultaneously, it is often necessary that the wetting agent should not be adversely affected by the temperatures used in curing the resin. Thus if a resin requiring heat curing is used and curing is effected after the wetting agent has been applied to the mineral wool fibres the wetting agent should not undergo any

substantial decomposition at the curing temperature e.g. 200°C or, if decomposition occurs, the decomposition should be such that the decomposition product is also effective as a wetting agent. Also, in these circumstances the wetting agent should have sufficiently low volatility that it is not simply lost by evaporation during the curing step. Accordingly a preferred class of wetting agents are compounds of carbon, hydrogen and oxygen alone since coating agents including other elements e.g. nitrogen often have less satisfactory thermal stability and give rise to decomposition products which are not effective as wetting agents.

Preferred wetting agents are alkaryl polyglycol ethers e.g. 'Triton' CF10 and 'Lissapol' N. ('Lissapol' is a Trade Mark.) The wetting ability produced by Triton CF10 is reduced when it is subjected, in finely dispersed condition and in contact with air, to elevated temperatures e.g. 200°C but none the less the final wetting ability is still adequate without excessive quantities of the wetting agent needing to be applied initially to the mineral wool.

If the mineral wool products are made by a method which does not involve subjecting a mineral wool product containing the wetting agent to elevated temperatures then a very wide range of wetting agents can be used. Lauryl alcohol for example may be used as the wetting agent. The wetting agents which may be used in mineral wool products according to the invention may be anionic, cationic or, preferably, nonionic.

The amount of wetting agent which should be present depends on the efficacy of the chosen agent but generally at least 0.1% of wetting agent based on the weight of the mineral wool itself is needed.

Mineral wool products according to the invention are generally most useful when they have a density of up to 200 kg/m³, and the most preferred products have a density of less than 150 or even less than 100 kg/m³. The invention is of particular value in the case of products in the form of sheets having a thickness greater than 1 cm.

WHAT WE CLAIM IS:—

1. A dry porous mineral wool product having fibres of the mineral wool bonded together by a resin at fibre intersections and throughout the product there being such an amount of such a wetting agent on surfaces of the mineral wool fibres that the product is water-wettable.

2. A product according to claim 1 in which the wetting agent is present in an amount of 0.1 to 2% by weight based on the mineral wool fibres.

3. A product according to either preceding claim having a density of up to 150 kg/m³.

4. A product according to any preceding claim in the form of a sheet having a thickness greater than 1 cm.
5. A product according to any of claims 1 to 3 in granulated form.
6. A product according to any preceding claim in which the wetting agent is an alkylaryl polyglycol ether.
7. A product according to any preceding claim in which the resin is a phenol-formaldehyde or a urea-formaldehyde resin.
8. A product according to claim 1 substantially as hereinbefore described.
9. A method for making a product according to any of claims 1 to 4 comprising forming a suspension of mineral wool fibres in air, atomising a wetting agent and a solution of a thermosetting resin into the suspension, collecting the fibres as a fleece and curing the resin by heating.
10. A method according to claim 9 in which a single composition comprising the wetting agent and resin solution is atomised.
11. A method according to claim 9 substantially as hereinbefore described.
12. A mineral wool product made by a method according to any of claims 9 to 11.

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